



Microtechnology for Positioning, Navigation, and Timing (micro-PNT)

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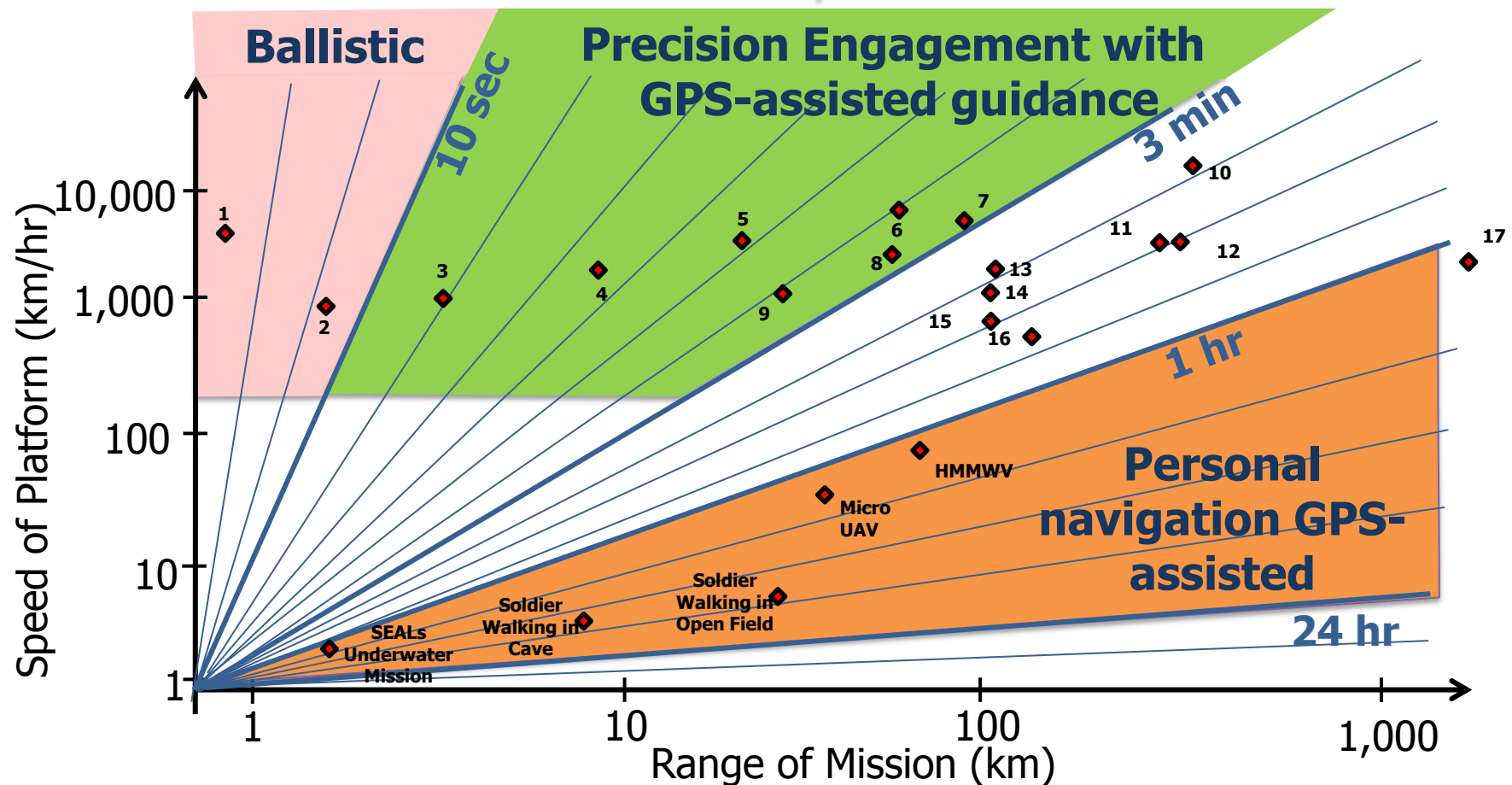
Solving an old problem with
modern technologies



"White space" in guidance and navigation

70% of missile missions have durations less than 3 minutes*

Current micro-PNT efforts

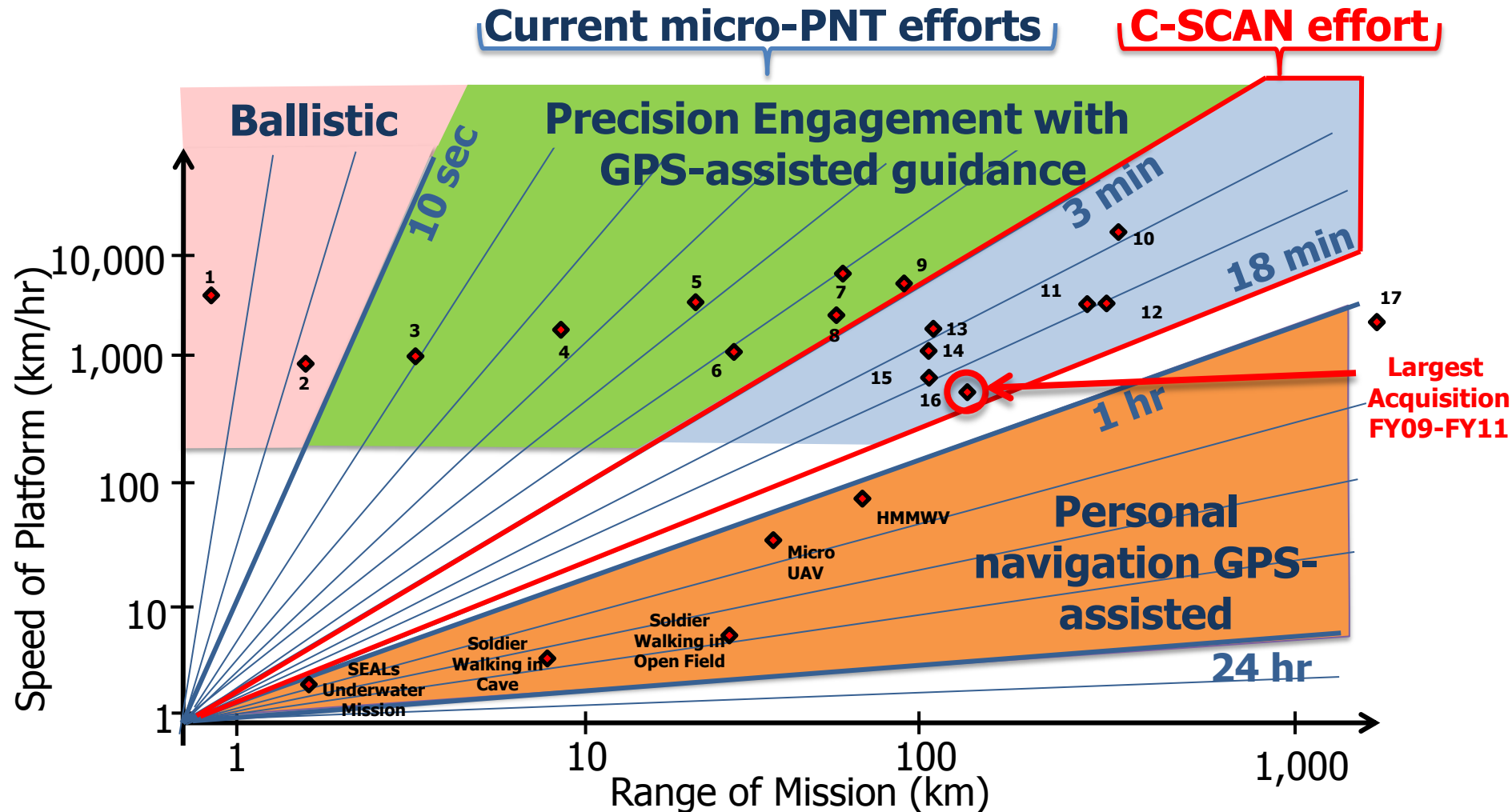


* Based on findings from budget documents for procurement programs (P-1) from the Office of the Under Secretary of Defense Comptroller Information System database for Army, Navy, and Air Force procurement for 2009, 2010 and 2011. Any platforms where there was no data in P-1 budgetary documents were assumed to be zero.



"White space" in guidance and navigation

98% of missile missions have durations less than 18 minutes*

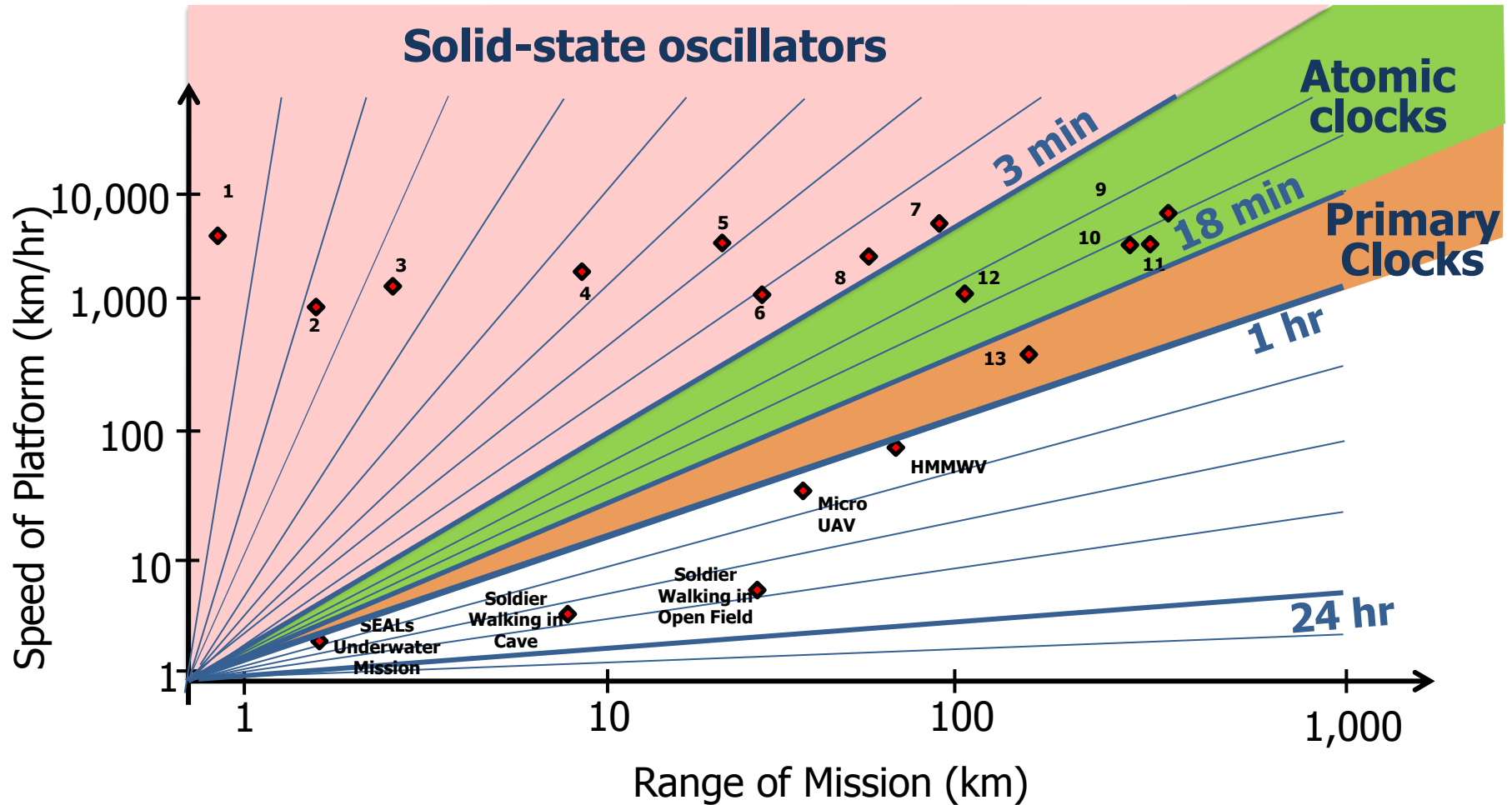


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"White space" in timing

Enable self-contained time keeping with micro technology





Micro-PNT scope: C-SCAN, PALADIN&T, PASCAL, TIMU, MRIG, IMPACT, IT-MARS, MINT, NGIMG, CSAC

❑ Clocks:

- (**CSAC**): Chip-Scale Atomic Clocks
- (**IMPACT**): Integrated Micro Primary Atomic Clock Technology

❑ Gyroscopes:

- (**NGIMG**): Navigation Grade Integrated Micromachined Gyroscope
- (**MRIG**): Micromachined Rate Integrating Gyroscope

❑ Microscale Integration:

- (**TIMU**): Timing and Inertial Measurement Unit
- (**PASCAL**): Primary and Secondary Calibration on Active Layer
- (**C-SCAN**): Chip-Scale Combinatorial Atomic Navigator
- (**MINT**): Micro Inertial Navigation Technology
- (**IT-MARS**): Information Tethered Micro Autonomous Rotary Stages

❑ Test and Evaluation:

- (**PALADIN & T**): Platform for Acquisition, Logging, and Analysis of Devices for Inertial Navigation & Timing

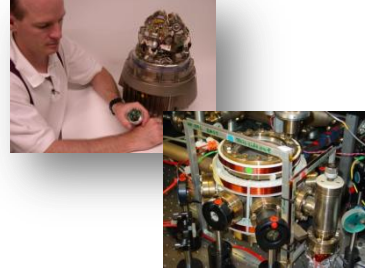


Micro-PNT Objective

The program addresses the emerging DOD need to:

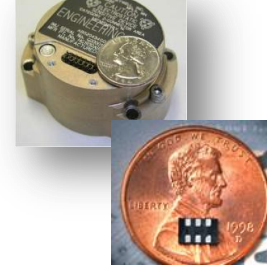
- Decrease reliance on GPS
- Increase system accuracy
- Reduce co-lateral damage
- Increase effective range
- Reduce SWAP&C

HG9900 Nav grade IMU



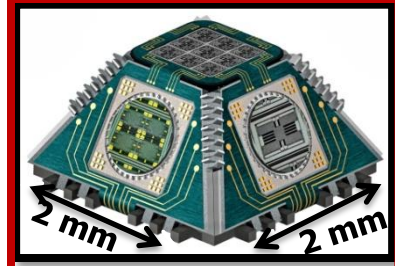
Magneto Optical trap

HG1940 MEMS IMU



Quartz Oscillator

This program



Parameters	Units	SOA	SOA MEMS	micro-PNT
Size	mm ³	1.6x10 ⁷	6.5x10 ⁴	8
Weight	gm	4.5x10 ³	2x10 ²	~2
Power	W	25	5	~1
Gyro Range	deg/sec (Hz)	1,000 (3)	3,600 (10)	15,000 (40)
Gyro Bias	deg/hr	0.02	4	0.01 (0.001)
Gyro ARW	deg/√hr	0.01	0.12	0.001 (0.0001)
Gyro Drift	ppm, 3σ	1	400	1
Accel. Range	g	25	70	1,000
Accel. Bias	mg	0.1	4	0.1 (0.001)
Misalignment	μ-radians, 3σ	200	1,000	100
Short-term Time Loss	ns/min	0.001	100	1
Long-term Time Loss	ns/month	10	N/A	32



Multi-institutional effort

Industry



20

Labs



6

Universities



14

Government



10



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